Mesoscale Analysis and Forecasting

1c. Given weather products, analyze and forecast for non-convective severe weather parameters IAW an evaluation checklist.

Satellite imagery

- Data collection and analysis for heavy snow determination
  - Visible and IR satellite data was collected whenever moderate or greater snow was observed at an official reporting station
  - IR imagery using the "MB" curve showed that the medium gray (-32° to -41°C) and light gray (-42° to -52°C) enhancement segments were important in heavy snow interpretation

IR temps related to heavy snow

Satellite imagery

- Heavy snow events were separated into four types according to the main atmosphere feature causing the heavy snow
  - High Plains cyclogenesis
    - Heavy snow events associated with cyclogenesis on the lee side of the Rocky Mountains
    - The best combination of deep layered moisture and vertical motion is usually near the southern edge of the enhanced clouds associated with the deformation zone
    - The area with the heaviest snow was related to the region of dark gray enhancement

High plains heavy snow

Satellite imagery

- Moderate snow was related to the region of medium and light gray enhancement
- Very little snow or none at all occurred in areas south of the IR enhancement

Satellite imagery

- Short-wave trough in southwesterly flow aloft
  - Heavy snow events were associated with short-wave troughs which may or may not be associated with surface cyclogenesis
  - Satellite cloud patterns were related to areas of PVA and warm-air advection and are seen as elongated and multi-layered
  - Heaviest snow amounts occurred near the southern edge of the dark gray enhancement and ended with the passage of these enhanced clouds

Short wave trough SW flow heavy snow

Satellite imagery

- Short-wave trough in northwesterly flow alo ft
  - Heavy snow events with characteristics similar to the warm season counterpart; the northwest flow severe weather outbreaks
  - Low and mid-level clouds were observed beneath the colder cloud tops (medium and light gray enhancements) with surface precipitation located near the western and southern edge
  - Heaviest snow amounts occurred near the edge of medium gray enhancement upstream toward the vorticity center

Short wave trough/NW flow Heavy snow

Satellite imagery

- Orographic
  - Heavy snow events from orographics usually occur during the early development of the high plains cyclogenesis type
  - Heaviest snow amounts occurred near the southern edge of the medium gray enhancement in areas of higher terrain

Orographic heavy snow

Satellite imagery

- Analyzing/Forecasting techniques from satellite image interpretation
  - Recognize the heavy snow type
  - Relate clouds to heaviest precipitation
    - Colder IR indicates increasing snowfall intensity; warmer IR indicates decreasing snowfall intensity
    - Growth of IR size indicates increasing snowfall intensity. Decay of IR size indicates decreasing snowfall intensity
    - If IR cloud edge becomes more (less) sharp or well-defined, this indicates an increase (decrease) in snowfall intensity

Satellite imagery

- If VIS becomes more (less) textured (lumpy) this indicates increasing (decreasing) snowfall intensity
- Convective clouds are a good indication of very intense snowfall

Satellite imagery

- Turbulence indicators using satellite imagery
  - Wave-type cloud patterns
    - Mountain Waves
      - Mid-level wave clouds that form on the lee side of the mountain ranges (discussed earlier)
      - The wavelength observed is directly proportional to the mean layer wind speed and instability, and can be used to determine turbulence intensities

Satellite imagery

- Billow Clouds
  - Short-lived, non-orographic wave clouds observed in both mid-level clouds and cirrus
  - Attributed to unstable waves that occur in strong vertical wind shear and high stability
  - Their wavelengths are usually shorter than those of mountain waves

Satellite imagery

- Transverse Banding
  - Wave-like bands oriented transverse to the upper flow in cirrus clouds
  - These bands have irregular wavelengths that are often large enough to be observed in infrared imagery
  - They are frequently located on the anticyclonic (equatorward) side of the subtropical jet stream and can produce severe turbulence when relatively wide, thick bands are present

Satellite imagery

- Turbulence signatures related to cloud boundaries
  - Deformation zones
    - One of the most prominent large scale turbulence produces
    - They are usually located on the north side of the "head" region of a coma cloud and also near the "tail" which consists of the cold-frontal cloud band
    - Moderate to severe turbulence is often found within about 3° latitude on either side of the deformation boundary north of the comma, especially during cyclogenesis

Satellite imagery

- Sharply curved bulges along jet cirrus border
  - Sharp anticyclonically curved bulges along a nearly straight segment of jet stream cirrus often produce moderate to severe turbulence
  - Turbulence extends from the crest of the anticyclonically curved bulge downstream for several hundred miles

Satellite imagery

- Leading edge of multi-layered frontal cloud bands
  - The downstream edge of a frontal cloud band also produces turbulence
  - If the ragged leading edge of the clouds has many closely spaced, parallel cirrus bands, turbulence is likely
  - This signature usually occurs at the axis of a sharp upper-level ridge
  - The most frequent turbulence intensity is light to moderate, although it can be severe.

Satellite imagery

- Developing dry slots in comma clouds
  - The indentation which forms on the rear of the comma cloud during cyclogenesis is often referred to as the dry slot
  - Moderate or severe clear air turbulence sometimes develops within this slot, especially during rapid cyclogenesis

Satellite imagery

- Moisture channel darkening
  - » Relatively dark bands which appear in water vapor imagery have been associated with moisture gradients in the region of jet streams, upper troughs and deformation zones
  - » Regions where darkening with time have occurred have been associated with strong turbulence
  - » The location of turbulence is typically both within, and just to either side of the dark band
  - » When the dark band begins to lighten, turbulence diminishes

Synoptic scale analysis

- 850 mb:
  - Isotherm (2° C interval) - red
  - Significant moisture (T_d Depression < 5° C) - green
  - Fronts - appropriate color
  - Troughs - black
  - Height centers - appropriate color

Synoptic scale analysis

- 700 mb:
  - Significant moisture (T_d Depression < 5° C) - green
  - Isotherms (5° C interval) - red
  - Troughs - black
  - Height Centers - appropriate colors

Synoptic scale analysis

- 500 mb:
  - Isotherms (5°C interval) - red
    - Thermal troughs - red
    - Cold pockets/pools - blue
  - Troughs - black
  - Height centers - appropriate color
  - Moisture(T_d Depression < 5°C) - green

Synoptic scale analysis

- 300 mb:
    - 1 Max wind bands - red
    - 2 Jet maximas - purple

- 200 mb:
    - Cold domes - blue
    - Warm sinks - red

Synoptic scale analysis

- Satellite imagery
  - Heavy snow
  - Wave clouds
  - Billow clouds
  - Transverse banding
  - Jet cirrus

Synoptic scale analysis

- Frontal bands
- Dry slots
- Moisture channel darkening

Synoptic scale analysis

- Surface chart
  - Isobars (4-mb interval) - black
  - Pressure centers - appropriate color
  - Fronts - appropriate color
  - Precipitation areas:
    - Heavy snow - hatched purple
    - Heavy rain - purple
    - Freezing precipitation - brown

Synoptic scale analysis

- Thickness - 5,400 m contour - green

- Vorticity - Maxes and lobes - appropriate color

- APPLICATION: Students will practice analysis and forecasting on appraisal packages in class.
- EVALUATION: Performance Progress Check will be given at the end of the unit.